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## Using complementation and resequencing to minimize transitions

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 Fujitsu Labs. of America Inc., USA

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### Abstract

In (Murgai et al., 1997) the following problem was addressed: given a set of data words or messages to be transmitted over a bus such that the sequence (order) in which they are transmitted is irrelevant, determine the optimum sequence that minimizes the total number of transitions on the bus. Stan and Burleson (1994) presented the bus-invert method as a means of encoding words for reducing I/O power, in which a word may be inverted and then transmitted if doing so reduces the number of transitions. In this paper, we combine the two paradigms into one—that of sequencing words under the bus-invert scheme for the minimum transitions, i.e., words can be complemented, reordered and then transmitted. We prove that this problem DOP1-Data Ordering Problem with Inversion-is NP-complete. We present a polynomial-time approximation algorithm to solve DOP1 that comes within a factor of 1.5 from the optimum. Experimental results show that, on average, the solutions generated by our algorithm were within 4.4% of the optimum, and that resequencing along with complementation leads to 34.4% reduction in switching activity.

Index Terms

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### Controlled Indexing

computational complexity, graph theory, minimisation, scheduling, switching theory, system buses

### Non-controlled Indexing

DOP1, Data Ordering Problem with Inversion, NP-complete, bus-invert method, complementation, encoding, optimum sequence, polynomial-time approximation algorithm, resequencing, system bus, transition minimization

### Author Keywords

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<u>L3</u> L2 and (threshold or limit)	3619	<u>L3</u>
<u>L2</u> count\$3 near10 data near10 bus	6764	<u>L2</u>
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L5    11 and L30    L5

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9	<input type="checkbox"/>	<input type="checkbox"/>	US 5119335	19920602	15	Data amplifying system in semiconductor memory	365/189.01	375/359
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11	<input type="checkbox"/>	<input type="checkbox"/>	US 5019720	19910528	19	Static type semiconductor memory	365/208	365/207
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## » Key

IEEE JNL IEEE Journal or Magazine

IEEE JNL IEEE Journal or Magazine

IEEE CNF IEEE Conference Proceeding

IEEE CNF IEEE Conference Proceeding

IEEE STD IEEE Standard

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## 1. Sign bit reduction encoding for low power applications

Saneei, M.; Afzali-Kusha, A.; Navabi, Z.;  
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Volume 4, 23-27 Jan. 2000 Page(s):2545 - 2550 vol.4  
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**9. Using complementation and resequencing to minimize transitions**

Murgai, R.; Fujita, M.; Oliveria, A.;  
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14-17 Oct. 1991 Page(s):526 - 532

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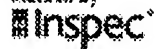
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Index Terms

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### Controlled Indexing

computational complexity graph theory minimisation scheduling switching theory system buses

### Non-controlled Indexing

DOP1 Data Ordering Problem with Inversion NP-complete bus-invert method complementation encoding optimum sequence polynomial-time approximation algorithm resequencing system bus transition minimization

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